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(54) Hemodialysis liquid feed system.

(57) A hemodialysis liquid feed system for feeding hemodialysis liquid to one or more hemodialysis machines, which comprises at least one principal container (10, 12) for containing the hemodialysis liquid or a liquid component thereof, connection means for connecting the principal container to a source (14) of carbon dioxide under super-atmosphere pressure, pressure regulator means (18) operative between the source (14) of carbon dioxide and the principal container (10, 12) to regulate the pressure value in the principal container and maintain this at a value in excess of atmosphere pressure, and conduit means (20) leading from the principal container for connection to the one or more hemodialysis machines.

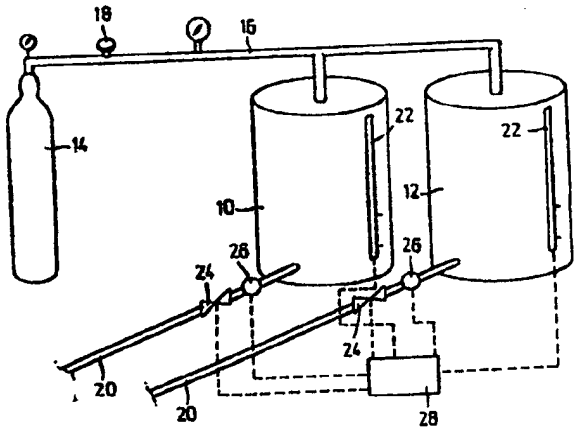

FIG. 1

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HEMODIALYSIS LIQUID FEED SYSTEM

This invention relates to a hemodialysis liquid feed system. More particularly the invention relates to a hemodialysis liquid feed system providing not only means for driving hemodialysis liquid or liquid components or liquid concentrates thereof from a container containing such liquids, but also means for securing the stability of otherwise unstable hemodialysis liquid components, in particular sodium bicarbonate solution or concentrate.

Present hemodialysis liquid feed systems, i.e. for feeding a concentrate from a container to a proportioning system where the concentrate is diluted to the correct dilution for use in a hemodialysis procedure, normally involve the use of pumps although gravity feed systems from central delivery systems have been considered. It has now been found, in accordance with the invention, that gas pressure applied in containers, for example containing a hemodialysis liquid concentrate or a liquid component thereof provides a very convenient and useful driving force which is readily available. This aspect, coupled with the fact that the gas employed in accordance with the invention is carbon dioxide, provides means for stabilizing sodium bicarbonate concentrates or the sodium bicarbonate dialysis liquid component of the dialysis procedure known as sodium bicarbonate dialysis.

Sodium bicarbonate dialysis has over the past years become recognised to be preferable to acetate dialysis. Acetate comprised in acetate dialysis liquid in acetate dialysis is transported into the blood stream of a patient undergoing treatment across the membrane of a membrane exchange device. The acetate is then metabolised by the liver to bicarbonate and in this fashion depleted bicarbonate buffer reserves can be restored. At least the initial stages of acetate dialysis can be uncomfortable for some patients and certain patients do not appear to tolerate acetate as well as others. Bicarbonate dialysis on the other hand provides an immediate availability of bicarbonate in the blood stream.

One factor which has had a limiting effect on change from acetate dialysis to bicarbonate dialysis is the poor stability of bicarbonate solutions. The sodium bicarbonate forms sodium carbonate and loses carbon dioxide to the atmosphere. This leads to a lowering of bicarbonate content in the solution and an increase in the pH of the solution as a result of the presence of sodium carbonate formed.

In accordance with the invention, it has been found that sodium bicarbonate solutions, or concentrates, useful in bicarbonate dialysis, can be stabilized by introducing a freshly prepared aqueous bicarbonate solution into a air-tight container, displacing air above the level of the solution with carbon dioxide, and introducing carbon dioxide under pressure into the container so that pressure in the container is in excess of atmospheric pressure. The pressure in the container is preferably at least 1.2 atmospheres and up to 2.5 atmospheres, a pressure of about 1.8 atmospheres being preferred.

The same considerations as above apply to hemodialysis liquid feed systems where hemodialysis liquid or hemodialysis liquid components, such as the above-mentioned bicarbonate component, are preferably available in storage for ready use. Thus, a hemodialysis liquid feed system in accordance with the invention comprises at least one principal container for containing the hemodialysis liquid or a liquid component thereof, connection means for connecting the principal container to a source of carbon dioxide under super-atmosphere pressure, pressure regulator means operative between the source of carbon dioxide and the principal container to regulate the pressure value in the principal container and maintain this at a value in excess of atmosphere pressure, and conduit means leading from the principal container for connection to the one or more hemodialysis machines. The gas pressure in the principal container most preferably provides a force on liquid in the container which is adequate to drive the liquid to the hemodialysis machine.

In bicarbonate dialysis, there will in general be two principal containers, one for containing a so-called acid hemodialysis liquid component and the other for containing a bicarbonate hemodialysis liquid component. The acid hemodialysis liquid component will for example comprise such components as magnesium, calcium, chloride, hydrogen ions, and an amount of acetate which assists in maintaining sterility of the solution. The bicarbonate component needs to be separated from the acid component since precipitation of calcium and magnesium would otherwise take place.

Conveniently, a single source of carbon dioxide and a single pressure regulator means is provided which is then operative between the single source of carbon dioxide and each of the principal containers. So that a more convenient means is available for sensing depletion of a principal container, a subsidiary container may be provided downstream of the principal container, i.e. intermediate the principal container and the hemodialysis machine. The principal container, or if a subsidiary container is proyided may comprise level sensor means and an electrovalve may be provided in the conduit and arranged to close automatically when the level of liquid in the container falls below of predetermined level.

A conductivity probe may furthermore be provided in the conduit means for measuring the conductivity of liquid flowing to the hemodialysis machine. The electrovalve mentioned above may similarly be arranged to close automatically if the conductivity of the liquid is not within predetermined limit valves.

The invention will now be described with reference to the accompanying drawings showing an exemplary hemodialysis liquid feed system of the invention. In the drawings:

Figure 1 is a schematic diagram f a hemodialysis liquid feed system; and

Figure 2 is a side view of principal containers arranged in tandem fashion, which containers may also find application for transport of hemodialysis liquids.

Referring to Figure 1, principal containers 10 and 12 are provided for containing an acid component and a bicarbonate component. A source of carbon dioxide 14 is connected to each of the containers 10 and 12 via gas leads 16. Pressure regulator means 18 is operative between the source of carbon dioxide 14 and the principal container 10 and 12, which is employed to regulate the pressure in the containers and maintain this at a value in excess of atmospheric pressure.

Conduit means 20 lead from the principal containers 10 and 12 for connection to one or more hemodialysis machines (not shown). Level sensor means 22 are provided in each of the containers for sensing the level of dialysis liquid or component in the containers. Electrovalves 24 are arranged to close automatically, via electronic control 28 when the level of liquid falls below a predetermined level. Conductivity probes 26 are provided to measure the conductivity of solutions passing through the conduits 20 and the electrovalves 24 are similarly arranged to close automatically via electronic control 28 if the conductivity of the solution deviates outside of predetermined limit values.

In Figure 2, the principal containers 10, 12 are movated in tandem fashion on a stand 30. Connection means 32, 34 are provided for respective connection to the carbon dioxide source 14 and to conduit means 20 shown in Figure 1.

WHAT WE CLAIM IS :

1. A hemodialysis liquid feed system for feeding hemodialysis liquid to one or more hemodialysis machines, which comprises at least one principal container for containing the hemodialysis liquid or a liquid component thereof, connection means for connecting the principal container to a source of carbon dioxide under super-atmosphere pressure, pressure regulator means operative between the source of carbon dioxide and the principal container to regulate the pressure value in the principal container and maintain this a: a value in excess of atmosphere pressure, and conduit means leading from the principal container for connection to the one or more hemodialysis machines.

2. A hemodialysis liquid feed system according to claim 1, in which the pressure value in the principal container provides a force on hemodialysis liquid or a liquid component thereof in the principal container, which force is adequate to drive the hemodialysis liquid or liquid component from the principal container to the hemodialysis machine.

3. A hemodialysis liquid feed system according to claim 1 or claim 2, in which two prinpical containers are provided, one for containing one hemodialysis liquid component and the other for containing another hemodialysis liquid component.

4. A hemodialysis liquid feed system according to claim 3, in which the one principal container is for containing a so-called acid hemodialysis liquid component and in which the other principal container is for containing a sodium bicarbonate hemodialysis liquid component, each of which components may be in concentrated form for subsequent dilution.

5. A hemodialysis liquid feed system according to any one of claims 3 and 4, in which a single source of carbon dioxide and a single pressure regulator means is provided which is then operative between the single source of carbon dioxide and each of the principal containers.

6. A hemodialysis liquid feed system according to any one of the preceding claims, in which a subsidiary container is provided in the conduit means, intermediate the principal container and the one or more hemodialysis machines.

7. A hemodialysis liquid feed system according to any one of the preceding claims, in which level sensor means is provided for sensing the level of hemodialysis liquid or hemodialysis liquid component in the principal container or subsidiary container.

8. A hemodialysis liquid feed system according to claim 7, in which an electrovalve is provided in the conduit means which is arranged to automatically close the conduit means in response to a signal from the level of liquid in the container falls below a predetermined level.

9. A hemodialysis liquid feed system according to any one of the preceding claims, in which a conductivity probe is provided in the conduit means for measuring the conductivity of the hemodialysis liquid or hemodialysis liquid component flowing in the conduit means.

10. A hemodialysis liquid feed system according to claim 9, in which an electrovalve is provided in the conduit means which is arranged to automatically close the conduit means in response to a signal from the conductivity probe when the conductivity of the hemodialysis liquid or hemodialysis liquid component deviates outside of predetermined limit valves.

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- 1 -

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Our ref.: 1a - D 1807 EU

19. JULI 85

Further to our request for grant of a European patent of May 31st, 1985

A number of corrections are required as follows:

Page 2, line 9, change "a", second occurence to -an-.

Page 2, line 22, change "super-atmosphere" to -super-atmospheric-

Page 3, line 18, change "of" to -a-.

Page 3, line 23, change "valves" to -values-.

Page 4, line 10, add the language
-Reference numerals 17 and 19 respectively refer to manometers for measuring the gas pressure in carbon dioxide source 14 and in the gas leads 16.-

Page 4, line 22, change "movated" to -mounted-.

Claim 1, line 5, change "super-atmosphere" to -super-atmospheric-.

Claim 8, at the end of line 3, add the language -th level sensor when-

Claim 10, last line, change "valves" to -values-.

In the Abstract, lines 10 and 15, change "super-atmosphere" to -super-atmospheric-.

In the informal drawings, insert reference numerals -17- and -19- to respectively denote the manometers to the left and right of pressure regulator 18.

The above amendments concern only corrections of obvious errors.

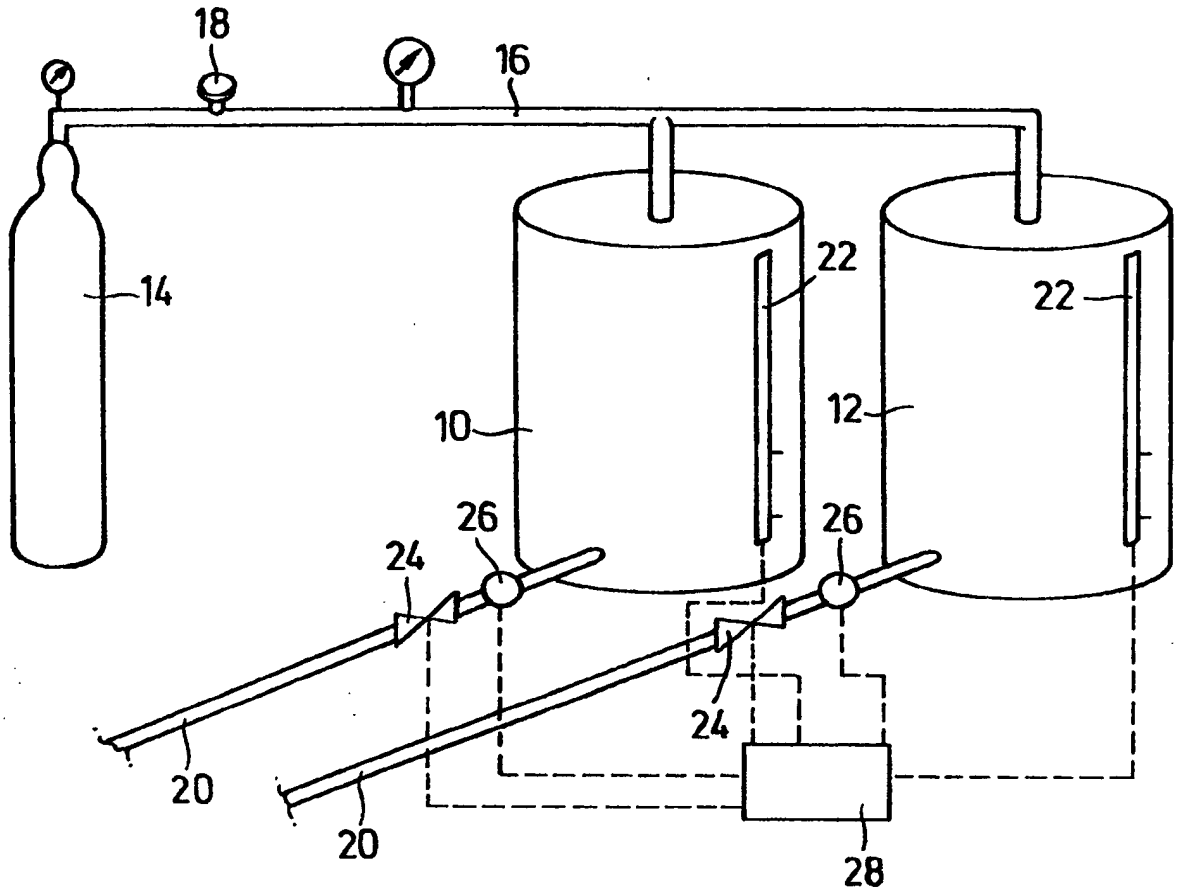

FIG. 1

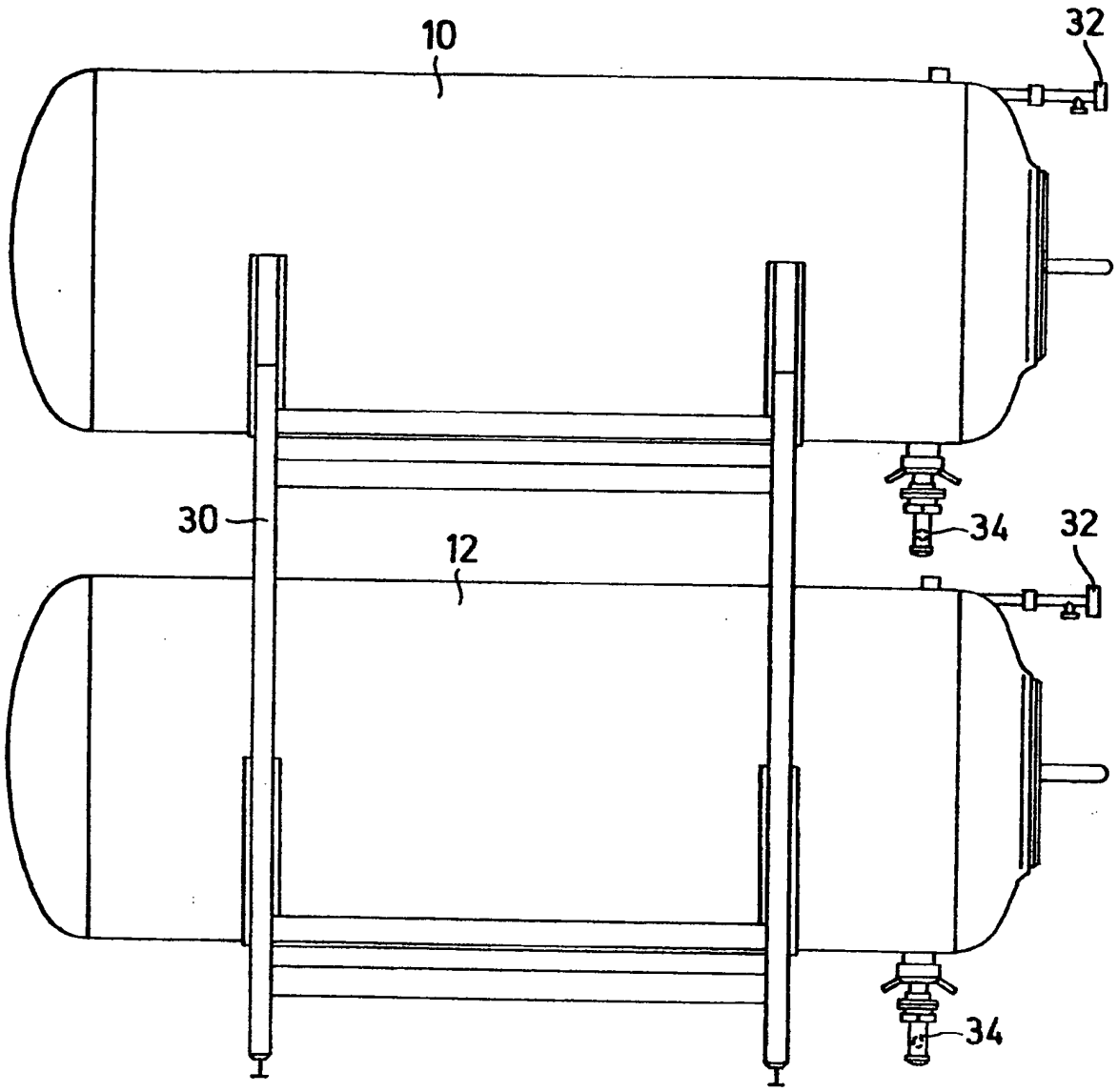

FIG. 2

0209607

Application number

EP 85 10 6727

European Patent Office

EUROPEAN SEARCH REPORT

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int Cl 4)
Y	GB-A-2 069 855 (TORAY INDUSTRIES INC.) * Figure 7; page 5, lines 52-88 *	1-4	A 61 M 1/14 B 67 D 5/54
Y	FR-A-1 435 806 (SAPADIS) * Whole document *	1-4	
A	FR-A-2 504 817 (COBE LABORATORIES INC.) * Figure 1; page 3, line 19 - page 4, line 2 *	4	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

A 61 M
B 67 D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18-11-1986	VEREECKE A.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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